OICW Fire Control System

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Contraves Brashear Systems has developed a compact, smart fire control system as a part of the Objective Individual Combat Weapon (OICW) Program to ensure that the 21st century soldier has the decided advantage in any situation. The specific purpose of the OICW system is to enhance the soldier's capability including the ability to defeat defilade targets. The OICW fire control system provides the capability to detect man and vehicle targets day or night, to provide an accurate laser range measurement to the target, and to calculate a full ballistic solution from which a corrected aimpoint is automatically presented to the gunner and the appropriate message is sent to the ammunition fuze. This system offers compatibility with Land Warrior, and with little modification can be adapted to offer these same features to larger caliber crew served weapons.

Contraves Brashear Systems' Objective Individual Combat Weapon (OICW) Fire Control System (FCS), shown in Figure 1, was developed to give the U.S. Army combat soldiers and the U.S. Marines a distinct advantage in either rural or MOUT (military operations on urban terrain) arenas. Teamed with Alliant Techsystems as the prime contractor and the high explosive (HE) munitions developer, Heckler & Koch as the weapon developer, and Dynamit Nobel as the advanced propulsion system technology provider, Contraves Brashear Systems has developed a smart fire control system as a part of a complete multi-functional weapon system to ensure the 21st century soldier has the decided advantage in any situation.

Figure 1 – OICW Fire Control System

The primary purpose of the OICW system, shown in Figure 2, is to incapacitate the enemy soldier in the defilade position after he has gone to cover. This purpose is accomplished by accurately placing an air bursting munition over the soldier who is seemingly in a protected position. To achieve this purpose, the OICW fire control system measures the range to the target, presents a ballistically corrected aimpoint to the soldier and programs the fuze. The weapon precisely and reliably projects the air bursting munition whose fuze accurately detonates at the commanded range spreading lethal fragments over the protected soldier. In this way, the integrated design of the weapon, ammunition and fire control system provides a much higher probability of incapacitation than any other current individual weapon.

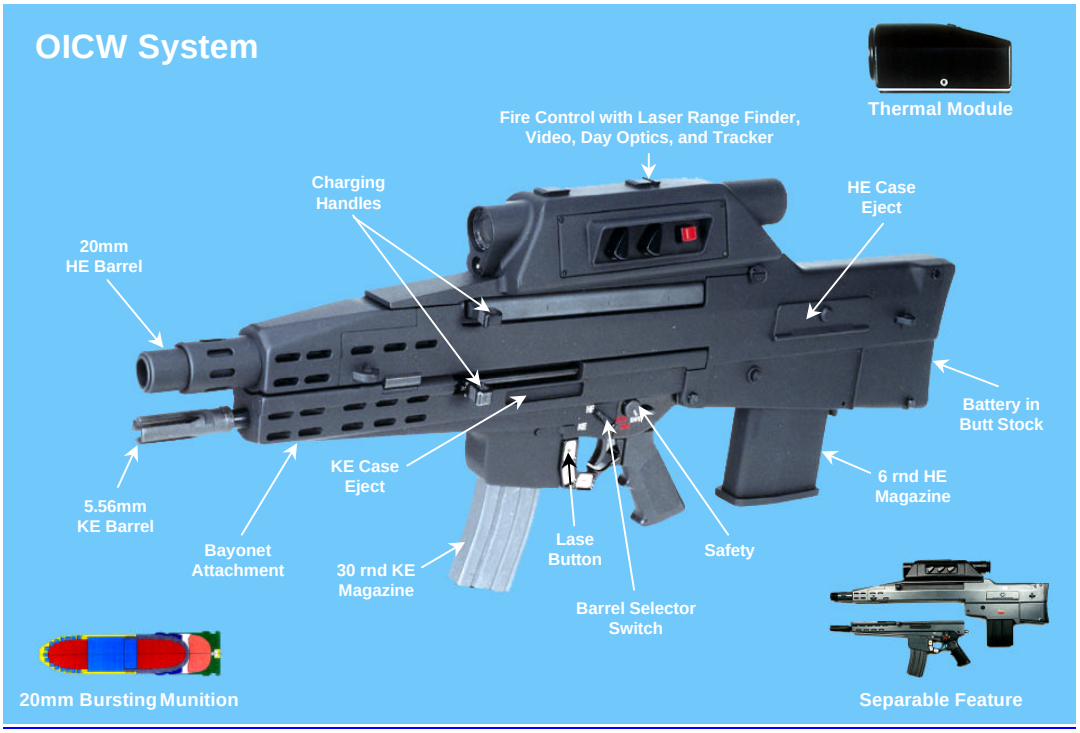


Figure 2 – OICW System

The OICW weapon is of an advanced design employing two barrels - one is a 20 mm barrel for the HE air bursting munitions to support the goals of incapacitating defilade targets and increasing the probability of incapacitating other targets, and the other is a 5.56 mm kinetic energy (KE) barrel for standard munitions to provide for self defense against close in targets. The barrels are configured in an

over/under fashion on a bullpup style weapon with a single trigger. It is constructed in a modular manner that allows the two weapons to be separated and operated without the other. An recoil mitigation system allows the recoil force of this weapon to be significantly less than that of an M14.

The OICW air bursting ammunition uses dual warheads to optimize its lethal area effectiveness. Controlled fragmentation allows for the optimal mass and spatial distribution to maximize the probability of incapacitation and suppression. The range traveled by the projectile is established using a turns counting technique for precise on target detonation. In addition, the fuze has several modes that can be commanded by the fire control system. These modes allow the ammunition to automatically air burst above the target (bursting mode), detonate on contact with the target (point detonation mode), detonate after perforating the target (point detonation with delay mode) or air burst after a fixed delay beyond the target that is lased upon (window mode). These modes are quickly selectable by turning a multi-position switch on the FCS allowing the gunner to maximize weapon effectiveness for each situation.

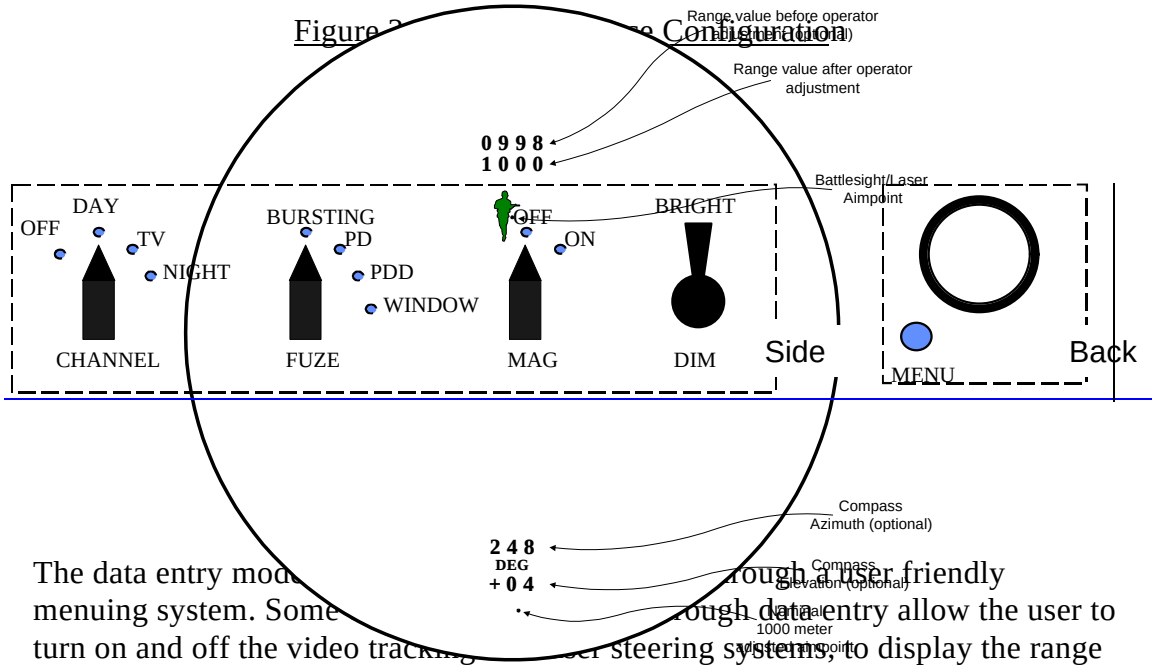
The prototype OICW FCS, as shown in Figure 1, is a rugged, compact system weighing approximately five pounds (including the battery placed in the butt stock of the weapon). The production system will include an infrared module and a combat ID system internal to the housing and will weigh significantly less than the prototype.

The OICW FCS provides three different display channels – day, TV and night. The day channel provides a high quality, 3x magnification, optical viewing system with a large field of view, nominally 11 degrees, for practical target acquisition. These direct view optics provide the additional advantage of being available for use in an unpowered state. The TV channel employs a charged coupled device (CCD) camera with the same large field of view, but offers the user selectable options for an additional 2x electronic magnification and/or video tracking and laser steering. The night channel offers these same options, but extends the operation of the system beyond dawn to dusk into and through the night. The resolution of each of these channels exceeds the requirement to detect personnel targets out to 500 meters and vehicle targets out to 1000 meters.

Each of these channels presents a familiar red dot with an adjustable brightness so that it is both visible in bright sunlight and clear in the darkness of night to indicate the position of the laser aimpoint and the ballistically corrected adjusted aimpoint. The laser aimpoint is coincident with the battlesight (the adjusted aimpoint at a specified range under nominal conditions) to offer the soldier a reference point from which to operate the weapon effectively at a moment’s notice. Figure 3 shows a sample view through the eyepiece.

The FCS is operated using a combination of buttons integrated into the weapon, switches on the fire control unit itself and a menuing system integrated into the FCS. The buttons on the weapon provide a means of activating the laser and incrementing its result using the trigger finger. The switches on the fire control, depicted in Figure 4, are used to activate functions that may be needed immediately on the battlefield. These functions include selecting the FCS channel (off, day, TV or night), selecting the fuze mode (bursting, point detonate, point detonate with delay or window), selecting the electronic magnification (on or off), adjusting the brightness of the aimpoint, and activating the data entry mode.

Figure 3 [illegible] Configuration



The data entry mod[illegible]rough a user friendly menuing system. Some [illegible]rough data entry allow the user to turn on and off the video tracking [illegible] steering systems, to display the range data both with and without any operator adjustments, to display compass data, to select the ammunition type, and to select the time out period. In addition, the data entry mode allows the operator to enter other modes of the system including commanded built-in-test (BIT), boresighting, zeroing, compass calibration, maintenance and training. A sample menu, as viewed through the eyepiece, is shown in Figure 5.

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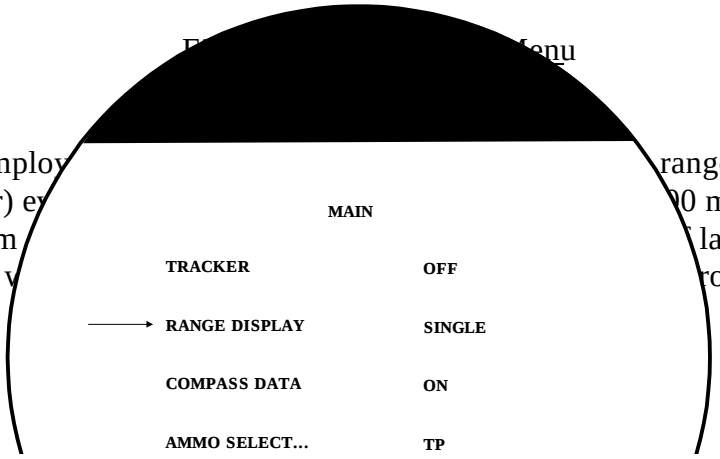

The FCS employ[illegible]range measurements (+/- 1 meter) ev[illegible]00 meters. The narrow beam [illegible] lasing on a man-sized target v[illegible]rom the

background. Since the range measurement is important in the OICW concept, or any other busting munition concept, and the user has a tendency to wobble while aiming a shoulder fired weapon, a series of pulses are transmitted and their returns are collected and processed through a modal analysis algorithm.

The modal analysis algorithm groups similar range measurements and estimates the true range to the target considering the returns from the largest grouping. The range resulting from the modal analysis algorithm is presented to the user who has the ability to increment and decrement the result in 1 meter increments. This capability allows the user to compensate for the target's motion since collecting the range information or to account for the fact that the range measurements may be made from a distinct, easy to lase target (building, wall, etc.) close to the actual target of interest.

The range measurement is further enhanced by the video tracking and laser steering systems. The FCS employs a video tracker to detect moving targets and to perform scene tracking. The tracking function allows the motion of the target (for moving targets) and the motion of the weapon introduced by the user to be characterized separately. This functionality allows the optional laser steering system to compensate for the soldier's wobble even for stationary targets. The laser steering system is steered to the target for moving targets identified by the video tracking system. The video tracking and laser steering systems are implemented in an integrated and automated way such that the soldier performs the same actions for both stationary and moving targets in all modes.

In addition to improving the range measurement, the video tracking system provides cues to the soldier, as shown in Figure 6, that improve his situational awareness. Up to four moving targets can be identified by the tracker at a time. Moving targets identified by the tracking system are indicated with an icon. The icon remains in the location where the target has gone to cover as an aid to the operator's ability to identify the current position of the targets.

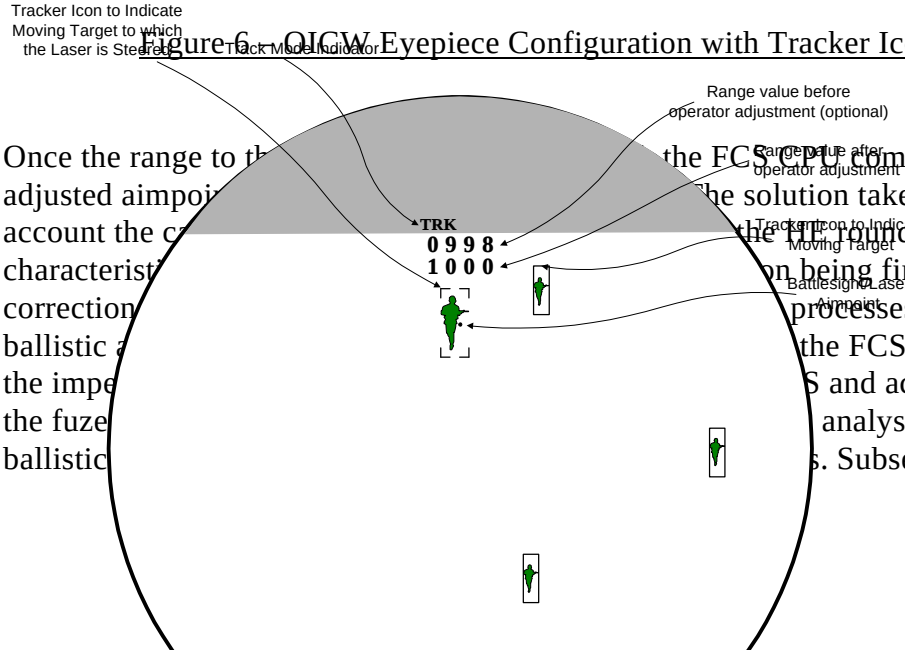

Figure 6. OICW Eyepiece Configuration with Tracker Icons

Once the range to th… the FCS CPU computes a new adjusted aimpoi… he solution takes into account the c… the HE round characterist… on being fired and any correction… processes. The ballistic a… the FCS, corrects for the impe… S and accounts for the fuze… analysis and ballistic… s. Subsequently, the

FCS generates a new red dot aimpoint and commands the turns count and mode to the fuze. The gunner places the red dot aimpoint onto the target and fires. The result is a system that successfully defeats defilade targets as evidenced in Figure 7.

Figure 7 – With OICW, There's No Place to Hide.

The cant angle and site angle measurements used in the ballistic algorithm are provided from an electronic sensor module included as a part of the OICW FCS with an accuracy of approximately 10 mils. This same device generates compass heading angles with similar accuracy. The data from the electronic sensor module is also used to support the Land Warrior interface. Additionally, the compass heading and site angle can be displayed to the operator at his request.

The OICW FCS is compatible with Land Warrior. This compatibility allows all of the electronic data presented in the FCS eyepiece to be displayed on Land Warrior's heads up display. This feature permits the OICW weapon to be used by the soldier from a protected position. For example, a soldier can shoot the weapon around the corner of a building without full exposure, but with all of the advantages of the OICW system. The knowledge of range and compass heading of the target also allows Land Warrior to identify the target's location so that indirect fire may be used against the target.

The Contraves Brashear Systems OICW Fire Control System provides the modern American soldier with enhancements to improve effectiveness in all possible scenarios. Among these enhancements are:

a) Assisting in target acquisition, day or night, with a thermal sight, video sight or the traditional day optical sight
b) Providing a means to accurately range to stationary or moving targets (+/- 1 meter) automatically and allowing the operator to manually increment or decrement the range in 1 meter increments
c) Automatically calculating and displaying aimpoints
d) Automatically setting the HE fuze before firing the round
e) Providing video magnification to enhance the video image
f) Providing a Land Warrior video and data interface
g) Providing a battlesight aimpoint for rapid response to threats
h) Providing compass data including heading, elevation, and cant
i) Allowing for consistent, simplified gunner action for all modes

Although the OICW FCS has been designed for a shouldered fired weapon for the individual soldier, the potential use of the resulting system extends beyond this application. The remaining part of this paper shows how this fire control system can be applied to other weapon systems such as the Mk19 40 mm Grenade Launcher and the M2 Heavy Barrel (HB) .50 Caliber Machine Gun.

The primary design considerations that affect applying the OICW FCS to another weapon system are the range over which the system must operate and the super elevation angle of the ammunition associated with this range. The OICW FCS is designed to operate out to 1000 meters with a maximum super elevation angle of approximately 8 degrees.

Increasing the range beyond 1000 meters requires a confirmation that both the laser configuration and the optical resolution are sufficient for the target of interest. Assuming a maximum range of 2000 meters and a vehicle target, Figure 8 shows that the current laser configuration is more than sufficient for achieving this range even under harsh environments.

The OICW FCS optics have a 3x magnification which is adequate to support the detection of a kneeling soldier out to 1000 meters using both the day and TV channels. To be able to extend this capability to 2000 meters, the optical design needs to be modified to increase the magnification. This modification is only a minor rework of the optics using the same lens diameters and only changing the lens prescriptions. The change in magnification, however, does reduce the system's field of view. The changes of magnification and field of view are not necessary if vehicles are the primary targets of interest beyond 1000 meters.

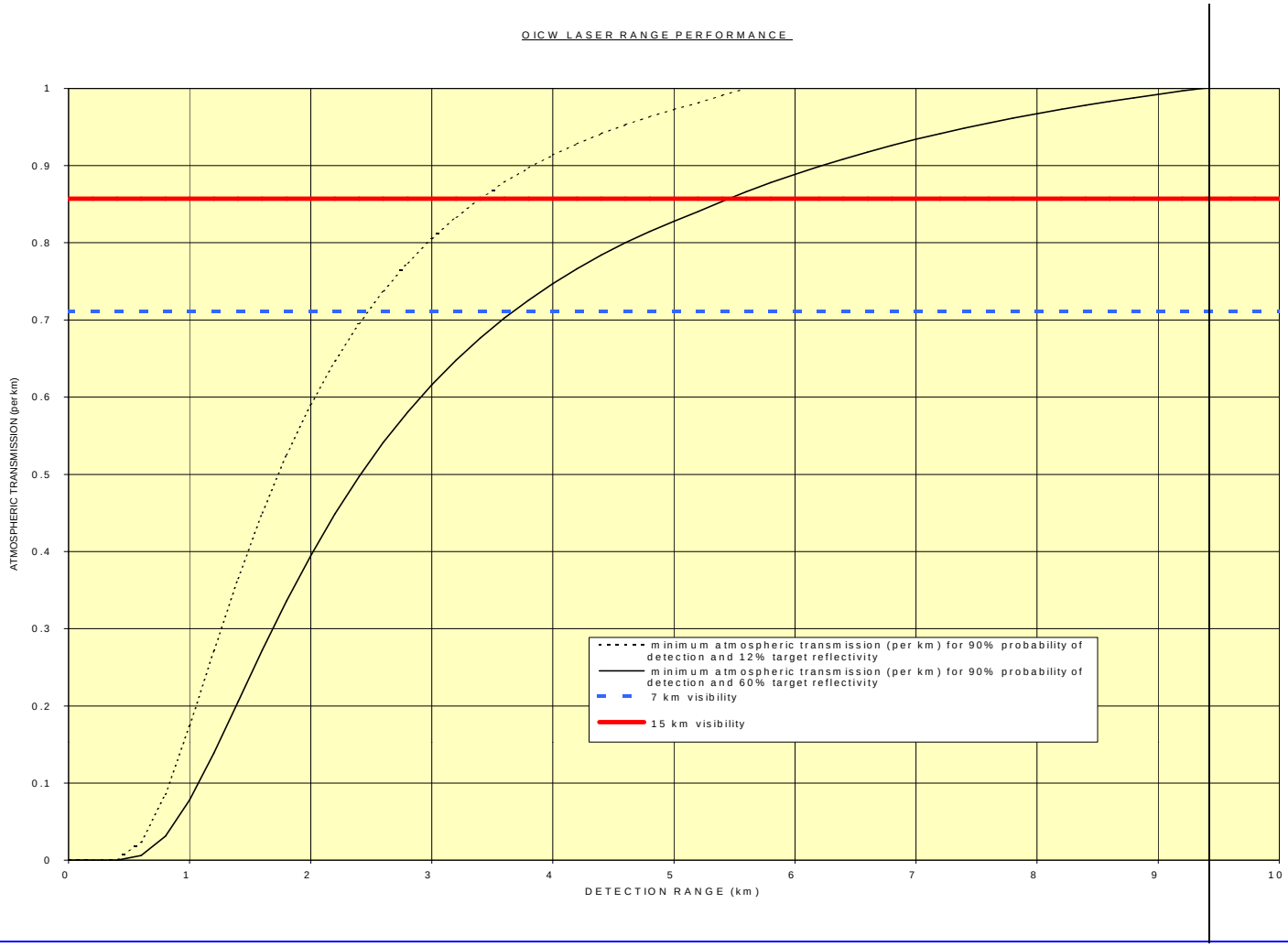

Figure 8 – OICW Laser Range Performance

The maximum super elevation angle over the range of operation varies significantly from weapon system to weapon system. Systems with a relatively flat ballistic trajectory, like the M2 HB .50 Caliber Machine Gun, do not require any changes to the OICW FCS because the maximum super elevation angle remains within the field of view for ranges out to 2000 meters. For weapon systems with greater super elevation angles, like the Mk19 40 mm Grenade Launcher, a super elevation mechanism can be used to extend the useful range of the fire control system. Contraves Brashear Systems has developed super elevation mechanisms that are either manual or automatic in operation.

With the technology developed under OICW, day/night imagery, laser ranging, a full ballistic fire control solution, an automatic red dot aimpoint, an automatic fuze setter, an increased probability of hit and the associated cost savings can be offered to the Mk19 40 mm Grenade Launcher, the M2 HB .50 Caliber Machine Gun and other similar systems. The FCS can be further enhanced to program a smart fuze for each of these systems, when available. The Mk19 lends itself to be converted to an air bursting system. Further enhancements include, calculating lead angles based on the video tracking data and increasing the display resolution from VGA to SVGA to extend the range at which targets can be detected and recognized. For weapon systems mounted on a vehicle, the FCS could be enhanced for remote operation so that the video and tracker data, range, aimpoint, bearing, etc. are displayed within the vehicle. The accurate range and compass data provided by the FCS, combined with the Global Positioning System (GPS) of the vehicle, could also serve as a forward artillery observation post capable of transmitting range, bearing and other target data back to the field commander's post.

The OICW FCS can be applied to the 155 mm Howitzer system for self-protection while in the direct fire mode. The same technology can also be readily applied to medium caliber, rapid-fire systems for combat vehicles.

Contraves Brashear Systems' OICW FCS is a state-of-the-art system that offers day/night target acquisition, an accurate laser range finder system, and a full ballistic solution that automatically provides a corrected red dot aimpoint to the soldier and the appropriate message to the fuze. This compact, rugged system is compatible with Land Warrior. With little modification, the OICW FCS can be adapted to offer these same features to other larger caliber crew served weapons.